Acoustic Communications
In VSW/SZ Channels

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LONG-TERM GOAL

Our long-term goal is to understand the limitations imposed on acoustic telemetry by the Very Shallow Water/Surf Zone (VSW/SZ) channel. We are particularly interested in developing robust signaling methods appropriate for multiple access operations in this channel.

OBJECTIVES

We wish to establish whether the channel will support acoustic communications and acoustics-based navigation. We are particularly interested in developing the statistical envelope of telemetry performance relative to measured time-varying characteristics of the acoustic/oceanographic channel, and in representing that relationship via appropriate statistical models. We intend to apply this knowledge to support our Command and Control (C^2), image processing, and image transmission capabilities with robotic crawlers and Autonomous Underwater Vehicles (AUVs) operating in the VSW/SZ region.

APPROACH

Our efforts are based on at-sea experiments and demonstrations, post-experiment data analyses, channel modeling, and communications systems development. We re-engineered the packaging of the Foster-Miller control system on our Basic Unexploded Ordnance Gathering System (BUGS) crawler, integrated it with our ATM 885 modem, and demonstrated good C^2 capabilities at South Florida Ocean Measuring Center (SFOMC) in Florida. We will build upon this success to integrate a camera and image processing capabilities with our modem within the crawler. We will collaborate with Chuck Bernstein of Coastal Systems Station (CSS) in this effort.

We are using results from SignalEx experiments and surf zone experiments to develop and validate models of time-varying channels. These site-specific models are being integrated into the real-time channel simulator, CHANSIM. CHANSIM is now fully capable of driving any modem with realistic analog representations of ocean channels. We are prepared to provide a simulated multi-access environment for evaluation of C^2 and data transmission capabilities for mine countermeasure purposes.

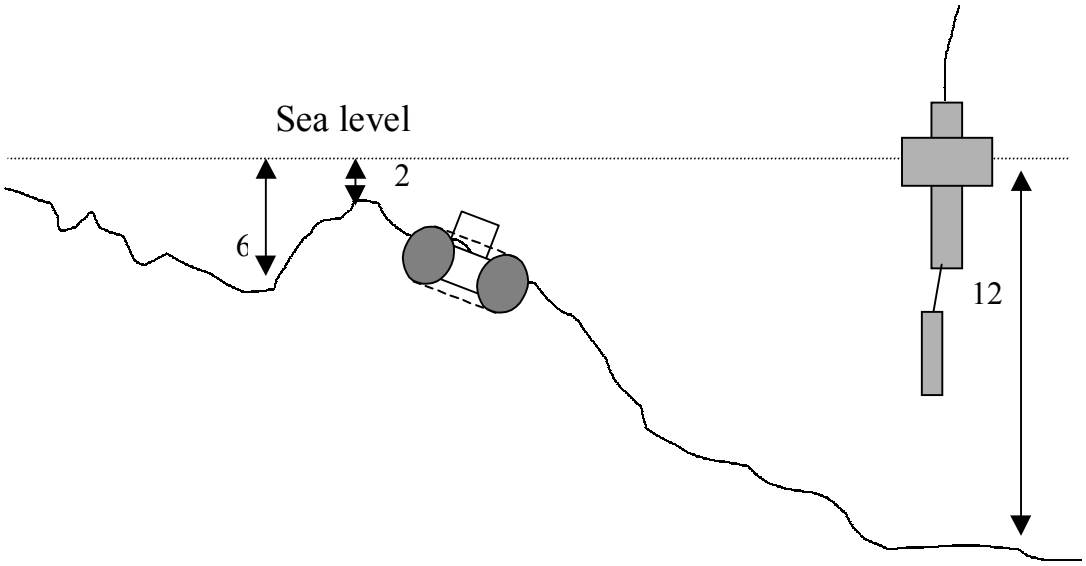
We are collaborating with Lee Freitag of the Woods Hole Institute of Oceanography (WHOI) in the implementation of his signaling scheme in the ATM 885 modem. This is an intial step in providing interoperability among the various modems developed by the Office of Naval Research (ONR).

We are collaborating with Lockheed (CETUS vehicle) and Sippican (EMAT vehicle) to introduce acomms into their systems. We intend to demonstrate two-way acomms with both vehicles during the AUV/Modem Fest in 2001.

WORK COMPLETED

The demonstration at SFOMC was the focal point of our modem-related efforts for the year. We successfully demonstrated C^2 of our Foster-Miller crawler during the SFOMC exercise, with control maintained into and through the surf zone at a sand bar. See the following figure. Both the crawler and the Benthos-designed gateway buoy contained an ATM 885 modem, which used a standard 600 bps signaling scheme. The maximum range from the gateway buoy to the crawler was about 200 m.

CHANSIM is essentially complete, and has been used extensively to drive the ATM 885 modem. Results from several SignalEx experiments were used to develop statistical models of time-varying scattering functions, which were then inserted into the simulator.



Probe and communications signals were developed specifically for the surf zone environment at Scripps pier. These included four signals: frequency-hopped MFSK (type B) conveying data at about 30 bps; packed MFSK at about 300 bps; two slightly different QPSK signals at about 4 kbps data rate. These signals were supplied to Dr. Grant Deane at the Scripps Institute of Oceanography as part of the Surf Zone Acoustic Telemetry Experiment (SZATE).

We began the implementation in the ATM 885 modem of the WHOI frequency-hopped bfsk signaling scheme. During the SFOMC demonstration we transmitted this signal to a WHOI receiver, were it was properly received and decoded.

IMPACT/APPLICATION

Controlling the crawler at SFOMC under quite difficult conditions indicates the feasibility of doing this operationally. The 600 bps data rate was much higher than we expected to be effective, especially within the breaking surf. We intend to pursue this development by including add-on devices,

beginning with a camera, which can be controlled by acomms means. We further intend to experiment with the ATM 885 modem in several AUVs to provide both C^2 and data transfer.

The development of an experimentally-based, time-varying representation of the channel scattering function, and its incorporation in CHANSIM, provides a realistic and reliable means of testing modems under multi-access and interference-rich conditions. The scattering model was developed as the result of the SignalEx experiments, and the previous year's Near Shore Acoustic Experiment.

The development by Benthos of its gateway buoy provides a low-cost, radio frequency (RF), acoustic link to an undersea network. It can easily be deployed by two people from a small boat. The RF link includes either a spread-spectrum radio or cell phone. Any acoustic modem with an RS232 link may be employed.

TRANSITIONS

Benthos is now commercializing the gateway buoy.

CHANSIM is ready for outside evaluation and Navy use.

The ATM 885 modem is being offered commercially

RELATED PROJECTS

We have supported the Telesonar program (ONR/SPAWAR) for several years, and this work is highly complementary, although Telesonar is not concerned with surf zone signaling. We have supported the Swedish Navy with defining requirements and proposing solutions for underwater communications in the Baltic Sea. We are working with DSO of Singapore to develop underwater communications and surveillance capabilities.